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Cultural and Chemical Weed Control in *Field Crops*

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The information contained in this publication summarizes the researches that have been conducted by the Minnesota Agricultural Experiment Station and elsewhere on the effectiveness and practicability of using pesticide chemicals in controlling agricultural pests. In general, the problems that might result from residues remaining on agricultural commodities from the use of these chemicals have not been investigated at this experiment station. *Therefore, no claims or representations are made by the University of Minnesota or its officers or employees that the chemical pesticides discussed will or will not have residues. As a consequence any person who uses any of the chemicals discussed in this publication does so at his own risk.*

This position is made necessary because of the enactment in July 1954 of Public Law 518, an amendment (commonly known as the Miller amendment) to the Federal Food, Drug and Cosmetic Act. This law makes liable for seizure any raw agricultural commodity moving in interstate commerce which carries a pesticide residue (1) for which no exemption or tolerance has been established or (2) which exceeds the tolerance established by the Food and Drug Administration. Similar state regulations cover intrastate shipments.

It is dangerous to ignore approved label directions. Labels should, therefore, be read carefully. The University will make every attempt to provide new information on residues and tolerance as it becomes available.

The rates of application listed herein refer to acid equivalent or active ingredient rather than the amount of commercial product. Avoid repeated and prolonged contact with ALL herbicides, especially direct contact with the skin and eyes.

For information on specific problems contact your county agent.

STAFF MEMBERS CONCERNED WITH FIELD CROP WEED CONTROL

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Chemical Weed Control Practices

A number of terms are used to describe herbicide applications. Those listed below are used here:

Preplow application—Herbicide applied to soil and/or foliage of weeds before plowing.

Preplanting application—Herbicide applied before the crop is planted.

Preemergence application—Herbicide applied after the crop is planted but before it or the weeds have emerged.

Postemergence application—Herbicide applied to the crop and weeds after they emerge.

Band application—Herbicide applied to a 12- to 14-inch band centered over the crop row.

Drop-nozzle application—Herbicide applied by means of nozzles mounted on extensions below the spray boom to avoid spraying upper parts of the crop plant.

Directed-spray application—Herbicide applied to a band over the row that includes the base of crop plants and the weeds in the row. Spray is directed across the row from nozzles positioned near ground level on each side of the row. This type of application allows use of chemicals that will injure the crop plant if more than a small part of the plant is contacted by spray. Special units that guide from the ground or mount on cultivators must be used.

Preemergence Applications

Several excellent preemergence herbicides are now available for the farmer's use. These herbicides generally give good weed control but weather has an affect on their action. Weed control may be poor if there is no rainfall soon after treatment. On the other hand, if rainfall is very heavy, some preemergence herbicides will move downward in the soil. This may result in poor weed control and/or crop injury. Soil type can affect weed control also. Follow instructions on the herbicide label for the soil type.

Numerous tests have been conducted in Minnesota to determine the overall effectiveness of preemergence herbicides. In comparisons where the number of tests is considered adequate, this folder shows the percentage of tests where an herbicide gave good weed control.

Granular Versus Spray Forms of Herbicides

Granular forms of herbicides are a recent development. Tests indicate that weed control varies in

some granular and spray forms of an herbicide. Granule forms require no mixing and they can be used directly from the package. This is an advantage over spray forms. The cost of granules is higher (about 25 percent) than the cost of an equal amount of the spray form. The uniformity of application with granule applicators is poorer than that of sprayers, especially on rough seedbeds. In some instances, this has resulted in variable weed control. Chemicals that cause iritation, such as CDAA and CDAA-T, may be used with greater safety in the granular form than in the spray form.

CULTURAL AND CHEMICAL WEED CONTROL IN FIELD CROPS

Corn

Weed control in corn is based on a combination of cultural practices and herbicide applications.

Cultural practices—Cultural practices include seedbed preparation, establishment of an adequate stand, and timely and effective cultivations. The use of shallow cultivation tools, such as the rotary hoe, is highly recommended for early cultivation.

Herbicides—Preemergence applications of simazine and atrazine at 2 to 4 pounds per acre have given fair to good kill of annual weeds with no injury to corn. In county demonstration tests conducted in 1959 to 1962, grass control was rated good in 80 percent of the trials and annual broad-leaved weed control was rated good in 85 percent of the trials when atrazine was applied preemergence at 3 pounds per acre. In earlier tests, simazine applied at 3 pounds per acre gave good weed control in 64 percent of the trials. Applications of granular atrazine at 3 pounds active ingredient per acre gave good weed control in 60 to 66 percent of the 1960 to 1962 trials A 4-pound-per-acre rate of atrizine or simazine should be used on heavy soils or those high in organic matter. Two pounds per acre of these compounds is adequate on sandy soils. rate of atrazine or simazine should be used on heavy rainfall is low. Either compound may remain in some soils for more than one season. Toxic residues are more likely to persist if rainfall is low.

A 2- or 3-pound-per-acre application of atrazine or simazine sometimes affects small grains, flax, sugar beets, soybeans, and other legumes planted the following spring. Damage can be minimized by the use of the lowest rate of chemical consistent with good weed control, use of band applications rather than broadcast applications, use of the wettable powder rather than the granular form of the chemicals, and plowing

or thorough tillage of the soil prior to planting susceptible crops. If granules are used at more than 2 pounds per acre follow corn with corn.

Used in preemergence applications at 4 pounds per acre, CDAA (Randox) controls annual grasses but is not effective on most annual broad-leaved weeds. Annual grasses are controlled for about 4 weeks. CDAA-T (Randox-T) contains an additive that kills some broad-leaved species not controlled by CDAA. Grass control with liquid CDAA was rated fair to good in 69 percent of the 1959 to 1962 county demonstration trials while the granular form was fair to good in 79 percent of the trials. Broad-leaved weed control was rated fair to good in 28 percent of the trials when the liquid was used and 40 percent when granules were applied. In 1960 to 1962 trials, CDAA-T at 3.5 pounds per acre of CDAA and 7 pounds per acre of TCBC gave fair to good grass control in 77 percent of the tests when liquid was used and in 84 percent of the tests when granules were applied. Broad-leaved weed control was fair to good in 75 percent of the tests when liquid was used and 79 percent when granules were applied. Soybeans were affected in some instances by soil residues when they were planted in areas treated with CDAA-T the previous crop season.

Preemergence applications of linuron (Lorox) at 3 pounds per acre have shown some promise in Minnesota trials. In a few instances severe stunting and stand reductions of corn have occurred.

Preemergence applications of 2,4-D as granules or sprays are not recommended in Minnesota. The control of annual grasses has been erratic and injury to the corn is likely if moderate or heavy rains occur shortly after treatment. This herbicide gave fair to good grass control in 27 percent of the county demonstration tests and fair to good broad-leaved weed control in 48 percent.

In postemergence applications annual broad-leaved weeds have been controlled with broadcast applications of ¼ to ½ pound per acre of 2,4-D amine when the corn is less than 8 inches tall. The ¼-pound rate has been adequate for susceptible weeds and is less dangerous to corn. The ½-pound rate has been satisfactory for moderately resistant kinds. One pound has been necessary for resistant weeds but corn has usually been injured.

If 2,4-D esters are used, application rates should be reduced by about one-third. Since the ester forms are volatile, vapor injury to nearby susceptible crops is a possibility. The use of amines eliminates the danger of vapor injury because amines are not volatile. Spray drift from either amines or esters of 2,4-D will injure susceptible plants.

To reduce the danger of 2,4-D injury when the corn is more than 8 inches tall, spraying the upper leaves and leaf whorl of corn can be avoided by using drop nozzles between the rows when the corn is sufficiently tall. However, adequate spray coverage of the tops of the weeds is necessary for maximum weed control. If nozzles are directed toward the row from both sides, the herbicide concentration must be reduced to compensate for the double coverage.

Some injury may result if the corn is sprayed with 2,4-D during the period from emergence to tasseling. Brittleness followed by bending or breaking of stalks is the most serious type of injury, and it may result in severe stand losses when followed by a storm or careless cultivation.

Several factors influence the degree of injury resulting from 2,4-D treatments. Corn growing rapidly is more susceptible than corn developing under less favorable growth conditions. When temperatures exceed 85° F. just before or at the time of 2,4-D application, the corn is more likely to be injured. At the rates of application commonly used, the stage of growth at which treatment is made during the period from emergence to tasseling is less important than the effects of environmental factors.

MCPA has not proved less injurious to corn than 2,4-D.

Early postemergence sprays of atrazine at 2 to 4 pounds per acre effectively control annual weeds with no injury to corn. Broad-leaved weed control is especially good. Grass control is less consistent. Grass control was good in 69 percent of the 1961-1962 county demonstration tests and broad-leaved weed control was good in 80 percent of the tests when atrazine was applied at 3 pounds per acre. Apply atrazine while weeds are less than 1½ inches tall and within 3 weeks after the corn is planted. Early postemergence applications of atrazine tend to be somewhat more effective on heavier soils and under conditions of lower rainfall than equivalent preemergence applications.

Carefully applied directed-sprays of dalapon-2,4-D, mixtures at rates of 1½ to 2 pounds of dalapon and ½ pound of 2,4-D per acre can be used on corn from 8 to 16 inches tall. This mixture will stunt or kill most weeds within the row which are hard to control by cultivation. Especially designed sprayer equipment has been developed to make directed-spray applications. Attachments lift the corn leaves as the spray is directed at the base of the corn plants and the weeds in the row resulting in a minimum of spray contact with corn leaves. If excessive amounts of dalapon contact the corn leaves, plants become stunted and deformed. Twisted leaves and undeveloped ear husks are typical injury symtoms. **Caution**—Dalapon di-

rected-sprays have not been cleared for use as of December 1962. Clearance is expected soon. Ask your county agent or agricultural chemical dealer whether this practice has been cleared before you use it.

Directed-sprays of linuron at 1½ pounds per acre applied when the corn is 12 to 18 inches tall have shown some promise. The addition of a wetting agent is necessary for effective weed control. Care must be taken in application to minimize spray on the corn leaves. Linuron will kill leaf tissue it contacts and, if leaf kill is extensive, corn yields may be reduced.

Directed-sprays of either linuron or dalapon-2,4-D mixtures cannot be made to small corn. Therefore, early season weed growth must be controlled by some other means (i.e. use of rotary hoe, harrowing, pre-emergence herbicides or cultivation) to prevent weed losses from early weed competition. In many cases the use of directed sprays will be an emergency measure to control heavy weed stands within corn rows. **Caution**—Note linuron use restrictions on label.

DNBP (Premerge or Sinox PE) has killed small seedlings of annual weeds when applied to 4 pounds per acre to corn in the coleoptile (spike) to two-leaf stage using 20 to 40 gallons of water per acre. Since only the very small seedlings are killed, this treatment has been a chemical substitute for the rotary hoe. It has the advantage that its efficiency is not affected by soil moisture or structure.

If broad-leaved weed control is necessary after layby, 2,4-D ester at ½ pound per acre or 2,4-D amine at ¾ to 1 pound per acre may be applied using drop nozzles.

Flax

Cultural practices—Weeds are generally more of a problem in flax than in small grain; therefore, growers should sow flax on relatively clean land. Practice early afterharvest tillage of small grain stubble to control perennial weeds, prevent weed seed production, and stimulate annual weed seed germination in late summer and fall to prepare land for flax, except where afterharvest tillage results in serious wind erosion.

Another desirable weed control practice is to prevent weed seed production in the preceding corn, soybean, or other cultivated crop and prepare the seedbed for flax by shallow tillage. Delayed sowing of flax to permit spring tillage for wild oat control has been successful in some areas although the delay is sometimes detrimental to the flax. For delayed sowing, use early maturing varieties such as Bolley, Marine-62, or Windom.

Herbicides—MCPA is less likely to injure flax than 2,4-D. Best results with either herbicide have followed when spraying was done as soon as there was sufficient emergence of susceptible weeds to make it practical. Spraying may reduce yields of seed and straw unless weed competition is reduced sufficiently to offset injury from the chemicals.

Susceptible weeds like wild mustard have been killed with 2 to 3 ounces per acre of MCPA or 2,4-D in amine formulations. Lambsquarters, stinkweed, cocklebur, marsh elder, and ragweed have required 4 ounces. From 5 to 8 ounces per acre of MCPA or 2,4-D amine are required for wild buckwheat, thistles, smartweed, and red root pigweed. At these rates, flax may be injured; and a good kill of weeds seldom results though their growth is usually checked and seed production reduced. Flax is likely to be seriously hurt if sprayed during the period between bud stage and when 90 percent of the bolls have formed. Germination of the seed may be reduced by spraying between full bloom and the stage when the seeds are colored.

Weeds controlled more easily by MCPA than 2,4-D and vice versa are under SMALL GRAINS, page 11.

TCA at 5 pounds per acre or dalapon (Dowpon) at ¾ pound per acre will kill green, yellow, and giant foxtail in young flax. Best results have followed when the flax was at least 2 inches tall and the weeds less than 2 inches. TCA or dalapon can be applied in mixture with MCPA or 2,4-D to kill susceptible grass weeds and susceptible nongrass weeds with one application—but spraying must be done before early bud. Flax varieties recommended for use in Minnesota are approximately equal in tolerance to MCPA. However, differences in tolerance to dalapon are evident. Most tolerant to least tolerant are: Arny, Redwood, B-5128, Bolley, Marine-62, and Windom.

When flax is used as a companion crop to establish alfalfa, red clover, alsike clover, ladino clover, birdsfoot trefoil, timothy, meadow fescue, bromegrass, or crested wheatgrass, use MCPA or 2,4-D as directed for susceptible weeds in flax except that legume seedlings should be at least 2 inches tall. Sweetclover seedlings are likely to be killed and other legumes injured by either MCPA or 2,4-D. TCA or dalapon can be used on flax sown with alfalfa, sweetclover, or birdsfoot trefoil but will probably kill forage grasses and seriously injure red and alsike clovers.

Use 10 to 20 gallons per acre of spray solution when spraying with TCA, dalapon, or more than 4 ounces per acre of 2,4-D amine.

For chemical control of wild oats in flax see section on WILD OATS control on page 22.

Forages—Alfalfa and Clovers

Seedling legumes generally are poor competitors with weeds. Management practices in preceding crops such as use of intertilled crops and afterharvest tillage to make the land as weed free as possible for the legume seedlings are desirable.

Clipping of seedling legumes (except sweetclover) when sown alone, mowing the stubble of companion crops, and patch mowing of perennials help to control weeds.

Preplant incorporation treatments at 2 to 3 pounds of EPTC (Eptam) per acre have given effective control of annual broad-leaved and grass weeds in alfalfa, red clover, sweetclover, alsike clover, and birdsfoot trefoil when these legumes were sown without a grass in the mixture or a companion crop. Do not graze or feed legumes for 60 days after treatment with EPTC because of the possibility of residue.

Postemergence treatments with 4(2,4-DB) at ½ to 1½ pounds per acre can be used to control broadleaved weeds in seedling alfalfa, birdsfoot trefoil, red clover, alsike clover, and ladino clover when sown alone or with small grains. Spray when weeds are less than 3 inches tall, when the legumes are 2 to 3 inches tall, and small grains are 6 to 8 inches tall. Wild mustard is not effectively controlled by 4-(2,4-DB). To avoid residues, do not graze or harvest forage for livestock feed for 30 days after treatment.

Small grass weeds can be controlled in seedling alfalfa (2 to 3 inches tall) with dalapon at 1 pound per acre. **Caution:** Do not feed first-year crop to dairy animals or animals being finished for slaughter. First-year crop should not be sold commercially or shipped interstate.

Dalapon-4-(2,4-DB) mixtures may be used to control weeds in alfalfa sown without a forage grass or companion crop.

Seedling stands of ladino clover, alsike clover, red clover, and alfalfa sprayed with the sodium or amine salt of 2,4-D or MCPA at rates of ¼ pound per acre or less have not been seriously injured especially if a canopy of companion crops or weeds has been present. Reduced sprayer pressure helps minimize damage.

In established legumes, the amine salt of 4-(2,4-DB) can be applied at ½ to 2 pounds per acre or the ester of 4-(2,4-DB) can be applied at ½ to 1 pound per acre in 15 to 30 gallons of water per acre. Do not use more than ¾ pound of the ester per acre on red clover. Apply when the annual broad-leaved weeds are 2 to 3 inches tall or when perennials are 6 to 8 inches tall. The same feeding restrictions apply that were mentioned above.

The use of 2,4-D or MCPA is often hazardous. Either herbicide should be applied in the dormant stage of the legume—in late fall or in very early spring—to control weeds that are present at this time. MCPA or 2,4-D amine at 4 to 8 ounces per acre may be used during legume dormancy to control yellow rocket, a weed that is sometimes troublesome in legumes. White cockle is not controlled by 2,4-D or MCPA. Harvest of the legume before white cockle seed matures will reduce the rate of spread by seed.

In legumes grown for seed, the weed problem is different than where legumes are grown for forage, since seed production of weeds cannot be controlled by grazing or mowing. Furthermore, the generally effective method of frequent mowing to control perennial weeds cannot be used in seed fields.

On the other hand, there are several herbicides that can be used on seed fields if the forage is not fed to livestock. The possibility of herbicide residues in milk or meat prohibits the use of these compounds on forages grown for feed.

As mentioned under seedling legumes, EPTC can be used to establish legumes without a companion crop. TCA at 5 to 7 pounds per acre will control annual grasses in seedling stands of alfalfa, sweetclover, and birdsfoot trefoil, but should not be used when a small grain is the companion crop. TCA cannot be used on alsike or red clover. Grass weeds must be less than 2 to 3 inches tall to be controlled by TCA.

Dalapon has not injured seedling stands of alfalfa and birdsfoot trefoil when applied at 2 pounds per acre soon after emergence of grassy weeds. At 1 pound per acre good grass control has resulted. (Please note feeding restrictions mentioned above).

Established stands of alfalfa, sweetclover, and birdsfoot trefoil have been sprayed with TCA at 5 to 7 pounds per acre for control of many annual grasses (not wild oats) without permanent injury to the legumes. Do not treat ladino clover, alsike, and red clover with TCA.

A 2-pound-per-acre dalapon application will suppress quackgrass in birdsfoot trefoil seed fields during the growing season. Treat early in the spring soon after quackgrass growth starts.

Rates of 1 to 1½ pounds per acre of 4-(2,4-DB) will control many broad-leaved weeds in legumes with little or no injury to the legumes. Forage cannot be fed to livestock if harvested within 30 days of treatment.

Early spraying of hoary alyssum in dormant red clover was satisfactory using either the amine or low volatile ester of 2,4-D or MCPA.

DNBP dried the foliage of crop and weeds, including Canada and perennial sow thistle, when alfalfa,

red clover, and alsike clover were sprayed pre-harvest with 1.87 pounds (1½ quarts) per acre.

Forages—Pastures and Meadows

Good management and controlled grazing are most important in any attempt at weed control in pastures and meadows.

In very weedy pastures where good perennial grasses are thin, reseeding may be the most important practice. To be successful, prepare a good firm seedbed for any reseeding, add fertilizer by soil test. Protect new seedlings from grazing until they are established and graze moderately thereafter. Plowing (or intensive surface tillage) and seeding to adapted grasses, where practicable, will usually eliminate many of the perennial pasture weeds.

Spraying with 1 to 2 pounds per acre of 2,4-D, 2,4,5-T, or a mixture of the two gives better control of more kinds of weeds by a single application than is obtained by a single mowing treatment. The weeds should be sprayed when growing actively. Repeated treatment for 2 or more years is usually necessary. In general, these chemicals have been used at rates necessary for weed or brush control without appreciable injury to the grasses but they will eliminate legumes.

Seedlings of perennial grasses have been treated with 2,4-D, when broad-leaved weeds were a problem, using up to ¾ pound per acre after the grass seedlings have reached the two- to four-leaf stage.

Mowing is the recommended practice for controlling many kinds of weeds if done at the right time and if repeated for 2, 3, or 4 years. In general, mow herbaceous weeds in the early bud to blossom stage.

Small Grains—Spring Wheat, Oats, and Barley

Wheat and barley are less sensitive than oats to 2,4-D applications made during the growing season. All three crops are sensitive as seedlings. Wheat and barley are relatively tolerant from the time five full leaves appear until the early-boot stage. During this period ¼ to ½ pound of 2,4-D ester or ½ to ⅔ pound of 2,4-D amine has usually been used to control broad-leaved weeds without injury to crops.

Avoid spraying wheat and barley in the boot stage of development. Varietal differences in wheat and barley have been unimportant.

Some injury to oats should be expected, but weed control generally will more than offset losses result-

ing from 2,4-D injury. Oats are more tolerant of MCPA than of 2,4-D, permitting the use of ½ pound per acre. At rates adequate for susceptible weeds like mustard, the stage at application is not so important as it is when ½ pound and more of 2,4-D amine is used. Varieties differ in their response to 2,4-D.

Weeds more easily controlled by MCPA than 2,4-D are hemp nettle, horse tail, buttercup, Tartary buckwheat, corn spurry, corn cockle, and perennial peppergrass. Those more easily controlled by 2,4-D than MCPA are Russian thistle, false flax, velvet weed, Jimson weed, smartweed, redroot pigweed, ball mustard, tansy mustard, and wild hemp.

Applications of 4-(2,4-DB) at ½ to 1½ pounds per acre made when small grains are 6 to 8 inches tall will control many broad-leaved weeds with no injury to legumes, except sweetclover. Mustard is not usually controlled by 4-(2,4-DB) and other weeds require higher rates than used for MCPA or 2,4-D. Grain should not be harvested for 30 days after treatment.

For control of wild oats in small grains see section on wild oat control (page 22).

Small Grains—Winter Wheat and Rye

Many annual broad-leaved weeds have been controlled in winter wheat and rye by spraying with 2,4-D—using the ester at ¼ to ½ pound per acre or the amine at ½ to ¾ pound per acre in the spring, after the grain is fully tillered but before it is in the boot. Winter wheat or rye should not be sprayed in the fall.

Sorghum

Sorghum will not germinate or grow in cold soil. Therefore, late planting in warmer soil, May 25 to June 15, is necessary if sorghum is to grow rapidly enough so that weeds can be controlled by cultivation. Later planting would be still more desirable but the length of the Minnesota growing season will not allow later planting if maximum grain production is desired.

Preemergence applications of CDAA (Randox) at 4 pounds per acre have been effective in controlling green, yellow, and giant foxtail. When grass weeds are a problem a treatment of this kind is essential to prevent drastic reductions in sorghum yields due to weed competition. Occasionally CDAA has caused injury but the sorghum has recovered.

2,4-D may be used at ¼ to ½ pound per acre for the control of broad-leaved weeds. However, injuries similar to those of corn may occur. Sorghum is most susceptible to 2,4-D in seedling, early boot, and pollination stages of growth. It is most tolerant when 4

to 12 inches tall but injury may occur at this stage of growth, also.

Soybeans

Cool soil temperatures slow the germination and growth of soybeans considerably so that weeds may gain a competitive advantage. However, in warm soils, soybeans are good competitors of weeds because germination and growth are rapid.

Several cultural practices control annual weeds in soybeans. Fall and early spring plowing plus tillage prior to delayed sowing of the crop can kill many weeds. Postemergence cultivation with the rotary hoe is effective if done when the weeds are small and soil conditions are favorable.

The chemicals DNBP, CIPC, NPA (Alanap), and PCP have occasionally caused injury to soybeans and have given erratic weed control.

Preemergence applications of CDAA at 4 pounds per acre has usually given satisfactory control of grasses with little or no injury to soybeans. Control of grasses was good in 50 percent of the 1959 to 1962 county demonstration tests when the liquid was used and 55 percent when granules were applied. Broad-leaved weed control was rated good in 11 percent of the tests where the liquid was used and 17 percent when granules were used.

Preemergence applications of amiben at 3 pounds per acre have controlled both annual broad-leaved and grass weeds. In the county demonstration tests grass control was rated good in 76 percent of the trials and broad-leaved weed control was rated good in 73 percent of the tests. In some cases slight stunting of soybeans treated with amiben has been noted. However, yields did not appear to be reduced.

Preemergence applications of linuron at 2 pounds per acre have been erratic in controlling weeds in Minnesota trials. Slight stunting of soybeans was observed in some trials. **Caution**—Linuron is cleared for use only on soybeans grown for seed.

Partial control of cocklebur was obtained when 4-(2,4-DB) was applied to soybeans in prebloom and bloom growth stages at a 0.2-pound-per-acre rate. Cockleburs showed some regrowth and bur production after a good initial dieback. Slight stunting of the soybeans was observed with no apparent reduction in yield.

Use band applications to reduce herbicide costs.

Sugar Beets

Herbicides may be used in sugar beets as supplements to conventional cultivation practices. Hand

labor, mostly hoeing, is still necessary but timely cultivations and herbicide applications can greatly reduce the amount of hand labor.

Annual grasses, except wild oats, may be controlled by TCA at 6 pounds per acre applied before emergence of the beets.

Dalapon at 3 to 4 pounds per acre will control most emerged annual grasses. For best control, grasses should be sprayed before they are 3 inches tall with 3 pounds of dalapon per acre. For taller grasses, 4 pounds per acre will be required and control is generally poorer.

A combination of EPTC (EPTAM) at 2 pounds per acre plus TCA at 6 pounds per acre incorporated into the soil before planting has given excellent control of annual grasses (particularly pigeon grass) and some broadleaf control in several years of testing. The combination has given satisfactory control under climatic conditions in which the single chemicals gave poor results. The treatment has at times given stand reduction and temporary stunting of beets. EPTC will probably be available to growers for use in combination with TCA on a limited experimental basis in 1963.

PEBC (Tillam) at 4 pounds per acre incorporated into the soil before planting has given satisfactory control of pigeon grass and some broadleaf control in several years of testing. It was used to a limited extent in growers' fields in 1962 with variable results.

For wild oats, barban (Carbyne) at 10 to 12 ounces per acre or DATC (Avadex) at 1½ to 2 pounds per acre will usually control wild oats without injury to sugar beets. (See section on wild oat control for more information on the use of these compounds.)

Certain broadleaf weeds—annual smartweeds, wild buckwheat, and marsh elder—may be controlled by a postemergence application of endothal at 1 to 1.8 pounds per acre applied when beets are in the three- to six-leaf stage. Beet leaves are usually burned around the edges but recovery is rapid. Endothal will generally give disappointing results on other broadleaf weeds found in Minnesota beet fields.

The use of chemicals for weed control must comply with the provisions of the Miller Amendment to the Federal Food, Drug and Cosmetic Act. *(See page 2.)*

Canada Thistle and Perennial Sow Thistle

CANADA THISTLE and perennial sow thistle can be controlled by cultural practices, chemical methods, and combinations of the two. Recommended cultural practices are:

1. Plow deep immediately before freezeup.

2. Plow 4 to 6 inches deep in the fall or use a one-way disk. About 2 weeks after the thistles come up, cultivate with a field cultivator equipped with wide overlapping duckfoot sweeps operated at a 4-inch depth. Alternatives can then be used.

   a. Cultivate every 3 or 4 weeks the next spring until July 1 and sow sorgo, Sudangrass, or proso millet. After harvest cultivate till freezeup. Repeat the treatment the next year or sow oats and spray with 2,4-D amine at 8 ounces per acre after the thistles have sent up a flower stem and again after harvest with a pound per acre of 2,4-D ester.

   b. Cultivate every 3 to 4 weeks until September and sow winter rye or winter wheat. After harvest cultivate until freezeup. Repeat the next year or fallow.

3. Sow alfalfa or an alfalfa-grass mixture on well-drained soils or reed canarygrass on wet soils and cut for hay over several years. If the stand of thistles is thick, cultivate preceding the sowing of the crop.

The tops of thistles can be killed and seed production prevented by spraying with 2,4-D or MCPA in a tolerant crop. Use 2,4-D on wheat, barley, or corn but MCPA is less injurious to oats. Use the amount of chemical recommended for the crop and spray as near to bud stage of the thistles as the crop will permit. See page 11.

Thistle stands can be greatly reduced by herbicide applications made after harvest of small grains and flax (if not underseeded with legumes), peas, or other

early maturing crops. Clip the thistles close to the ground or plow the area. Allow regrowth to reach 6 to 8 inches and apply 2,4-D or MCPA at 1 pound per acre or amitrole or amitrole-T at 4 pounds per acre. Plow or rework the area about 2 or 3 weeks after treatment.

Amitrole (Amino-Triazole or Weedazol), Amitrol-T or Cytrol will control Canada thistles satisfactorily when 4 pounds per acre in 30 gallons of water or more are used. Best results follow treatment just before bud stage. It is important that a full stand has emerged before spraying. If the thistles have been spring-plowed or for other reasons have been delayed in emergence, it is best to mow them and spray the regrowth when it is 6 to 8 inches tall. If thistles are in full bloom or mature it is best to mow them and spray the regrowth. Plowing or cultivation after spraying is not necessary but, if done, should be delayed at least 2 weeks after treatment.

To avoid amitrole residues, do not apply after October 1. Treated areas should not be planted to crops, grazed, or cut for hay for 8 months after treatment.

Soil sterilants such as sodium chlorate, borate, various mixtures of the two, and mixtures with 2,4-D or monuron can be used effectively but they remain in the soil for at least one season and are generally more expensive than amitrole. For information on application rates, see section on SOIL STERILANTS on page 23.

Cockleburs

Cockleburs are annual plants and can be controlled by preventing seed production. The bur contains two seeds, one of which germinates the year it is produced. The other germinates the next year or later. In the early stages cockleburs are very susceptible to 2,4-D or MCPA. Up to about 6 inches tall, they can be killed with 4 to 6 ounces per acre. Later they are stunted but seldom killed with 8 ounces.

Cockleburs in flax have been killed when they are less than 6 inches tall with 4 ounces of MCPA amine. In small grain or corn, 8 ounces of 2,4-D amine per acre has been best. Amiben at 3 pounds per acre will give partial control of cocklebur in soybeans.

Prebloom and bloom applications of 4-(2,4-DB) to cocklebur in soybeans have shown some promise. See the SOYBEAN section on page 13 for information on the use of amiben and 4-(2,4-DB).

Late summer applications of 2,4-D have shown some promise of stopping the formation of viable cocklebur seed. This use has not been registered by the U. S. Department of Agriculture.

Field Bindweed

Field bindweed can be controlled by cultural methods. They are the same as described for CANADA THISTLE, page 15.

Grazing is also effective in controlling field bindweed. Sow winter rye in the fall; pasture with sheep the next spring until the crop begins to head. Plow under the rye, and sow Sudangrass. Pasture the Sudangrass, plow, and sow winter rye. The next year, pasture or harvest the rye and cultivate until freeze-up.

Applications of ¾ to 1 pound of 2,4-D per acre in bud to bloom stage or on active growth in the fall have been effective. Retreatments in subsequent years are necessary.

In small areas and where soil sterility is not objectionable, 5 to 6 pounds per square rod of dry sodium chlorate followed a year later with spot treatment of any remaining plants has been successful.

Monuron and boron compounds are also suitable. Eighty pounds of monuron in a large volume of water per acre, borax compounds at 10 pounds of B_2O_3 or borate-chlorate mixtures at 8 pounds of active ingredient per square rod have all been satisfactory. Another treatment may be required for surviving plants, beginning the second spring after the original treatment.

Trichlorobenzoic acids (Benzac or Trysben) are effective in controlling bindweed when applied at 15 to 20 pounds acid equivalent per acre. Mixtures of dichloro, trichloro, and tetrachloro benzoic acids (PBA) at rates of 30 to 50 pounds per acre have been as effective as TBA. The residual effect of these herbicides generally prevents or reduces crop production for 2 or more years.

Foxtail

There are three common kinds of foxtail in Minnesota—the yellow, the green (usually called pigeon-grass), and the giant. The giant species frequently grows 6 feet or more tall with a dense growth that can smother a crop. It can be distinguished from the other two foxtails by its leaves. The giant foxtail leaf is covered with short hairs on the upper surfaces, the green foxtail leaves are hairless, and the yellow has long hairs on the upper surface near the leaf base.

All three species have been controlled by use of one of the following practices:

1. Flax sprayed with TCA at the rate of 5 pounds or dalapon at ¾ to 1 pound per acre when the weeds were less than 2 inches tall. Alfalfa may be established when this practice is used.

2. Fallow after harvest of winter grains, early-maturing oats, or peas.

3. Alfalfa sown with an early maturing small grain and sprayed with dalapon at the rate of 1 pound per acre after harvest. The herbicide reduces the competition from the older foxtail and kills seedlings. This treatment is practical when there is a heavy stand of annual grassy weeds in alfalfa. Tame grasses included in the mixture are badly hurt or killed by dalapon.

4. See sections on CORN, page 4, and SOYBEANS, page 13, for control of annual grasses, including the foxtails, with other chemicals.

Leafy Spurge

For extensive infestations on arable land, intensive cultivation alternated with cropping will in time bring even the most persistent stands under control. The following practices have been found to work well.

Fall-plow 4 to 6 inches deep and cultivate at 2- to 3-week intervals until freezeup. In the spring cultivate 2 weeks after the spurge comes up and continue at 2- to 3-week intervals:

1. Until freezeup.

2. Until winter rye or winter wheat is sown. After harvest cultivate until time for sowing another crop of rye or wheat. Several years of this cropping and tillage are required to give complete elimination.

3. Until July 1, when Sudangrass is sown and harvested for hay. Cultivate until freezeup using a field cultivator with wide, overlapping duckfoot sweeps.

Grazing is an effective method of controlling leafy spurge. Sow winter rye at 2 bushels per acre in the fall and pasture in the spring with sheep until the crop begins to head; plow under the rye, and sow Sudangrass; pasture the Sudangrass, plow, and sow winter rye. The next year pasture or harvest the rye and cultivate the land until freezeup.

Leafy spurge on untillable land can be controlled by grazing with sheep if pastured early in the spring and continued all season.

Leafy spurge may be controlled with 2,4-D in conjunction with tillage. Practices that have been successful are:

1. Cultivate immediately after harvest until freeze-up. Apply 1 pound per acre of 2,4-D ester after spurge comes up in the spring. Cultivate whenever regrowth appears.

2. Cultivate intensively one season, then sow wheat or barley the next spring. Spray with ½ pound per acre of 2,4-D ester and cultivate after harvest until freeze-up. Repeat this cropping for 4 or 5 years. On rough or stony pasture, apply 2 pounds per acre of 2,4-D ester at the bud stage and apply again in the fall. The next spring apply nitrogen fertilizer and graze.

3. Cultivate intensively one season, then sow bromegrass in the fall. Spray with 1 pound of 2,4-D ester the next spring and fall. Repeat spraying the second year.

For rough or stony pastures, spray spurge with 2 pounds per acre of 2,4-D ester when in bud stage and re-treat whenever growth is 4 to 6 inches tall. Fertilize with nitrogen the next spring and graze moderately. Several years of repeated treatments are required.

Seed production of spurge in small grain can be prevented by spraying with ½ pound per acre of 2,4-D ester but many repeat sprayings are required to thin the stand.

Soil sterilants can be used to eliminate small patches. The following amounts of active ingredients per square rod usually kill 95 to 99 percent of the leafy spurge: 1. Concentrated Borascu—8 to 10 pounds; 2. Sodium chlorate—5 to 6 pounds; 3. Polybor-Chlorate or Atlacide—8 to 10 pounds; 4. DB-Granular—3.5 to 4 pounds; 5. Ammate—4 to 5 pounds; 6. Erbon (Novon or Baron)—½ to 1 pound; 7.TBA—⅛ pound.

Perennial Peppergrass and Hoary Cresses

Where soil type and topography permit, duckfoot cultivations at 2-week intervals will prevent seed production and reduce the stand. Sowing winter wheat or rye and cultivating after harvest will also give satisfactory reductions after 2 to 3 years. Where possible, a control program should make use of the combined beneficial effects of crop competition and intensive cultivation.

Top growth of these weeds can be killed in growing crops with ½ to 1 pound of 2,4-D per acre when the weeds were in bud. Re-treatment of fall rosettes at 1 to 2 pounds will cause substantial stand reductions. A combination of these treatments should give almost complete elimination after two or three seasons.

Soil sterilants will eliminate small patches or scattered plants that remained after these treatments have been used. Sodium chlorate at 4 to 6 pounds per square rod, concentrated Borascu or Polybor at

10 to 15 pounds, Polybor-chlorate at 6 to 8 pounds, or monuron (Telvar) at 40 pounds per acre have been used. A fall or early spring application of 2,4-D at 10 pounds per acre is also effective. Control seedlings by applying 2,4-D to the leaves, by cultivation, or by seeding bromegrass.

Quackgrass

Cultivation is the cheapest method of eradicating quackgrass on large areas if soil erosion is not a problem. Two methods are used: (1) the reduction of food reserves in the rootstocks to the point where the plant can no longer remain alive, or (2) the drying of rootstocks and top growth to the point where the plant dies. Occasionally the weed may be killed by exposing the rootstocks to freezing.

Weather in the spring usually does not favor killing quackgrass by drying. Therefore, cultivate whenever there is a leaf growth of 2 to 3 inches in order to exhaust the food reserves. Continue cultivations as late as possible before sowing a crop. A sharp disk or a duckfoot cultivator is satisfactory.

During the summer the most effective control results from drying the rootstocks and roots by bringing them to the surface by tillage to a depth of 3 or 4 inches with a spring-toothed cultivator. Repeated cultivations are necessary to uncover all fragments that have been buried. Cloddy soils require more thorough tillage than loose soils. Best results come from working up old hayfields and pastures.

Ordinarily there is no advantage from plowing before cultivating, but close grazing prior to cultivation makes control easier. If hay is harvested, cultivate immediately after the first crop has been removed. If the field cannot be cultivated during early fall, benefit will result from late fall tillage which exposes the rhizomes to freezing and drying over winter.

In either method, cultivations must be frequent and continued over a long enough period to free the soil of all living quack material. If the quack is in scattered patches, use a disk so rootstocks will not be dragged to clean parts of the field. In wet years or on poorly drained soils, cultivation is not very effective.

Quackgrass infestations can be reduced in clean-cultivated row crops by frequent cultivations. Best results are obtained using check planted corn. However, if wire check corn planting is used it is impossible to obtain corn populations neccessary for optimum yields without overcrowding the corn hill.

It is possible to greatly reduce or eliminate quackgrass infestations with chemicals. Weather conditions,

soil type, timing of treatments, and accompaning tillage will influence the results.

One of the most effective herbicides is atrazine. Applications of 2 to 4 pounds per acre to quackgrass in the fall or early spring have resulted in excellent reductions in quackgrass stands. The low rate is adequate on sandy soils but higher rates are necessary on heavier soils. Treated areas should be plowed and planted to corn only. Other crops are likely to be injured. If 3 or 4 pounds per acre are used, plant corn 2 years to avoid possible carryover injury.

Split applications, one-half of the atrazine on quackgrass sod in the fall or early spring and one-half on the corn as a preemergence treatment have appeared promising.

TCA applied at the rate of 22 pounds per acre in September or early October on land that has recently been plowed or thoroughly cultivated has given good quackgrass control. If the land is cropped the next year, either make a second application of 18 pounds per acre after plowing or cultivate after harvest to eradicate the quack. Under these conditions, better results have been obtained following flax than following corn. TCA on land that has been cropped does not give as good a kill as on old sod.

Normal growth of crops sown or planted in the spring following a fall application of 22 pounds of TCA can be expected from flax, potatoes, sugar beets, oats, corn, and strawberries if normal rainfall has occurred. If it has been dry following the application of TCA, all crops may be injured.

Dalapon (Dowpon) will give results similar to those obtained with TCA when applied to the soil or areas of scanty foliage. It is more effective than TCA on a good growth of foliage. Fall treatment of 12 to 15 pounds per acre followed in a week or two by plowing or other similar soil preparation gives good control of quackgrass the following year. Repeated treatments are necessary for eradication. Control is best when rain occurs between treatment and plowing. Response of spring-sown crops to residues of dalapon in the soil is similar to that for TCA.

Dalapon may also be applied to quackgrass in the spring. An application of 5 pounds per acre, when quackgrass leaves are about 6 inches tall, followed in 2 or 3 weeks by plowing or other soil tillage has proved most satisfactory. Crops should not be planted until 4 weeks after the application. Corn, wheat, and soybeans are especially sensitive to small amounts of dalapon in the soil.

In preliminary trials combination treatments of amitrole-T or dalapon applied 2 weeks prior to spring plowing for corn plus a preemergence application of atrazine showed promise for quackgrass control. Further trials using these combinations will be conducted.

Fall applications of Amitrol-T or Cytrol at 4 pounds per acre have appeared promising for the control of quackgrass in some tests.

Wild Oats

There are two major reasons for the difficulty in controlling wild oats: (1) its habit of shattering its seed before most small grain crops are harvested, and (2) its delayed germination characteristic. Unless the crop in which wild oats occurs is cut for hay, enough seed is shattered to infest the soil for years. The germination of the seed and the length of time it can remain viable depend on several factors.

Favorable temperature and moisture for germination are most common in fall and spring; very little seed germinates between June and September. Some seeds require afterripening or a rest period, a period in which the seed coat becomes more permeable to oxygen, which is necessary for germination. Seeds which require this afterripening germinate the next spring after they have been produced, or the following fall.

Seeds kept under conditions favorable for germination have grown in 2 or 3 years. However, when seeds are plowed under—or otherwise kept under conditions unfavorable for germination at the time the rest period has been completed—they may remain dormant and viable for a long time.

The following cultural methods of control are suggested:

1. Do not plow under seeds that have shattered from the current crop of wild oats. They may remain alive for many years when buried. Weathering helps break dormancy if seeds stay near the soil surface.

2. Cultivate shallow in the spring to break the soil crust and cover seed. Cultivate later to kill the wild oats that have germinated, and to bring up other seed that is no longer dormant. Late spring and summer cultivation should be shallow. About the middle of June sow a crop adapted to late sowing—such as early varieties of flax, potatoes, corn, sugar beets, proso millet, buckwheat, Sudangrass, and soybeans.

3. Cultivate as in (2.) and sow barley late. Use fertilizer and heavy rate of sowing.

4. Sow tame oats early and cut for hay before wild oats have formed seed. Plow immediately after the hay crop.

5. More than 1 year of early tillage, and delayed sowing or cutting of tame oats for hay, is necessary on badly infested fields.

6. Wild oats can regrow after cultivation. Avoid this by cultivating not earlier than the three-leaf stage, completely uprooting the plants.

Several herbicides are now available which may be used to control wild oats in a number of crops.

Preplant or preemergence incorporated applications of DATC (Avadex) at 1½ to 2 pounds per acre will control wild oats in flax with no injury to the crop. This compound may be used for the control of wild oats in barley if applied after planting at 1¼ pounds per acre. DATC-BW (Avadex-BW), a related compound, appears somewhat safer to barley and may be applied at the same rate either before or after seeding the barley. DATC-BW but not DATC may be used for the control of wild oats in hard red spring or durum wheat if applied at a lower application rate, 1 pound per acre, after seeding. Lower application rates, after-seeding applications, and greater depth of planting of the grain tend to reduce the possibility of crop injury from DATC or DATC-BW. However, the degree of wild oat control usually decreases as the application rate is reduced. DATC and DATC-BW require incorporation immediately after planting to prevent losses by evaporation. Shallow disking plus harrowing or harrowing twice at right angles have given satisfactory incorporation.

Alfalfa and clovers may be underseeded in crops treated with DATC or DATC-BW. Trials indicate that DATC will control wild oats in corn without injury to the corn.

Barban (Carbyne) should be applied to wild oats in the two-leaf stage, from 4 to 10 days after emergence, to obtain the greatest degree of control. Application rates of 4 to 6 ounces per acre will usually control wild oats in flax, wheat, and barley. Flax is more sensitive to barban than wheat, and barley is least sensitive. Spraying thin crop stands may result in unsatisfactory wild oat control. Thick stands of crop plants aid in suppression of wild oats and enhance the degree of control obtained with barban.

Barban may be used on crops undersown with alfalfa or clovers. For information on the control of wild oats in sugar beets, see page 14.

Soil Sterilants

Weeds in places where it is difficult to plow or mow or where complete vegetation control is desired can be controlled with herbicides, but the cost on an acre basis may be rather high. The use of chemicals for weed control must comply with the provisions of the Miller Amendment to the Federal Food, Drug and Cosmetic Act. (See page 2).

Larger dosages than those below will give better and more lasting control. Larger dosages are generally more necessary on low than on high, dry locations.

Lower dosages and less water or other carrier are needed if applications are made before plant growth becomes large and dense. For a temporary kill, use 5 to 10 pounds of dalapon plus 1 to 2 pounds of 2,4-D ester.

For long-time control of all vegetation, at least 1 year, the compounds described below may be used.

Atrazine and simazine are effective at rates of 10 to 20 pounds per acre. They are available as wettable powders and granules. They are not very effective on some woody plants.

BMM (Ureabor) is a mixture of monuron and borates containing 4 percent monuron. It is designed for use as a nonselective residual herbicide on industrial sites. Apply dry at 3 pounds per square rod.

Sodium chlorate at 4 to 6 pounds per square rod will control annuals, biennials, and most perennials. This compound has been used extensively in spot treatments to control bindweed, leafy spurge, Russian knapweed, Canada thistle, and other deep rooted perennials. Sodium chlorate is highly flammable when mixed with organic matter, so use it with care.

Polybor-chlorate or Atlacide at 8 to 10 pounds per square rod causes no fire hazard and may be used as sodium chlorate is used.

Erbon (Novon or Baron) is a nonselective herbicide effective on most broad-leaved and grass weeds. Docks, nutgrass, milkweed, and Canada thistle are resistant to erbon. Apply as a spray at 1 pound per square rod.

Monuron (Telvar), diuron (Karmex), and fenuron (Dybar) are related compounds that control vegetation at 20 to 40 pounds per acre (⅛ to ¼ pound per square rod). Diuron is the slowest acting but has the longest residual. Fenuron acts more rapidly but has a shorter residual. Monuron is intermediate in both respects. Monuron and diuron are wettable powders applied as sprays; fenuron is applied in dry form.

Urox is a chemical combination of monuron and TCA which maintains areas free of vegetation at 1½ pounds per square rod. It is applied dry or as a spray.

The first vegetation reinfesting sterilized areas is comprised of nongrass species. Relatively inexpensive treatments with 2,4-D ester at 1 pound per acre may maintain areas free of vegetation for several additional years.

CHEMICAL WEED CONTROL SUGGESTIONS *(See statement on page 2)*

(Rates refer to acid equivalent or active ingredient)

Field Crops

Crops	More information (page)	Chemicals	Rates per acre (pounds)	Time	Remarks
Wheat or barley	11-12	2,4-D amine or	⅔	Fifth leaf to early boot	Amine less injurious to crop.
		2,4-D ester	½	Fifth leaf to early boot	See section on wild oats.
Oats	11-12	2,4-D amine	½	Sixth leaf to early boot	MCPA less injurious to crop.
		MCPA amine	½	To early boot	
Flax	7-8	MCPA amine	¼	Before bud	MCPA less injurious to crop.
		2,4-D amine	¼	Before bud	Mixture of MCPA or 2,4-D with TCA or dalapon for broad-leaved and grassy weeds.
		TCA	5	Weeds 1 to 2 inches	Grassy weeds except wild oats.
		dalapon (Dowpon)	¾	Weeds 1 to 2 inches	See section on wild oats.
Corn	4-7	atrazine	2 to 4	Preemergence or early postemergence	
		simazine	2 to 4	Preemergence	Band applications reduce cost.
		CDAA (Randox)	4	Preemergence	
		CDAA-T (Randox-T)	3½*	Preemergence	
		DNBP amine (Premerge, Sinox PE)	4	At emergence	

*Plus TCBC at 7 pounds per acre.

Field Crops—*Continued*

Crops	More information (page)	Chemicals	Rates per acre (pounds)	Time	Remarks
Corn	4-7	2,4-D amine	¼ to ½	After two-leaf stage to layby	Corn most susceptible during rapid growth.
		2,4-D ester	1/6 to ⅓		Use drop nozzles after corn is 8 inches tall.
		2,4-D amine	½ to 1	After layby	Spray base of stalks only.
		2,4-D ester	⅓ to ⅔	After layby	
Alfalfa and clover in small grains	9	2,4-D or MCPA amine	¼	Not before 2 inches tall	Sweetclover injured. Canopy of crop or weeds reduces injury.
		4-(2,4-DB)	½ to 1½	Not before 2 inches tall	Sweetclover injured.
Alfalfa, sweetclover, and birdsfoot trefoil in flax	9	TCA	5	Weeds 1 to 2 inches	For grass weeds.
		dalapon (Dowpon)	¾		Will injure red and alsike clover.
Legume establishment without a companion crop	9-10	EPTC (Eptam)	3	Preplanting incorporation	To avoid residues, do not harvest or graze forage for 60 days.
		4-(2,4-DB)	½ to 1	Legumes 2 to 3 inches	Sweetclover injured. Do not harvest or graze for 30 days.
		dalapon	1	Legumes 2 to 3 inches	Will injure red and alsike clover. Do not feed first year to dairy cows or animals being finished for slaughter.

Field Crops—*Continued*

Crops	More information (page)	Chemicals	Rates per acre (pounds)	Remarks	Time
Established legumes	9-10	4-(2,4-DB) amine 4-2(2,4-DB) ester	½ to 2 ½ to 1	When annual weeds are 2 to 3 inches tall or perennials 6 to 8 inches tall.	Do not use more than ¾ pound per acre of ester form on red clover. Do not graze or harvest for feeding within 30 days after treatment.
Sorghum	12-13	CDAA (Randox) 2,4-D amine	4 ½	Preemergence 4 to 12 inches	Band applications reduce cost. For broad-leaved weeds.
Soybeans	13	CDAA (Randox) amiben	4 3	Preemergence Preemergence	Band applications reduce cost.
Sugar beets	13-14	TCA dalapon (Dowpon)	6 3	Preemergence Weeds 1 to 3 inches	For grassy weeds except wild oats.

Weeds

Weeds	More information (page)	Chemicals	Rates per acre (pounds)	Time	Remarks
Quackgrass	20-22	TCA	22	Sept. or early Oct.	Best on plowed ground.
			18	Next fall after harvest	To kill escaped plants.
		dalapon (Dowpon)	12 to 15	Fall	Foliage application, plowed 1 or 2 weeks later.
		dalapon (Dowpon)	5	Spring	Foliage application, plowed 1 or 2 weeks later.
		atrazine	2 to 4	Spring or fall	Use low rate on sandy soils. Only corn can be grown the year after treatment.
Field bindweed:	17				
On noncrop land		2,4-D ester	1	Bud to bloom or late fall	Re-treat second year.
On crop land		2,4-D amine	½	Bud to bloom	
Leafy spurge:	18-19				
On noncrop land		2,4-D ester	2 to 3	Bud	Re-treat growth when 4 to 6 inches.
On crop land		2,4-D ester	½	Bud	Safest in wheat or barley. Cultivate after harvest until freezup.
Canada and sow thistle	15-16	2,4-D amine	½	Just before bud	Can spray in tolerant crop.
		2,4-D ester	1	Fall rosette	Plow or clip in fall and spray when 6 inches.
		amitrole	4	Just before bud or Regrowth when 6 to 8 inches after clipping or plowing.	A full stand before spraying is important.
		amitrole-T	4		

Weeds—*Continued*

Weeds	More information (page)	Chemicals	Rates per acre (pounds)	Time	Remarks
Wild Oats	14, 22, 23	barban (Carbyne)	4 to 6 oz. (wheat or barley)	When wild oats in two-leaf stage	
		barban (Carbyne)	10 to 12 oz. (sugar beets)		Time of spraying very important.
		DATC (Avadex)	1 to 2	Pre- or postplanting	Must be incorporated into soil.
		DATC-BW (Avadex-BW)		(See text)	See text for rates on specific crops.
Spot spraying perennial weeds	23-24		Rate per square rod (pounds)		
		sodium chlorate	3 to 5		Highly flammable.
		Polybor chlorate, Atlacide	8 to 10		Poor control of grasses.
		TBA (Benzac, Trysben)	⅛ to ¼	Spring or fall	Poor control of grasses.
		PBA	¼ to ½		
		DB Granular	3½ to 4		
		amitrole or amitrol-T	½ oz.	Summer or fall	For thistles. (See restrictions on page 16.)
		Concentrated Borascu	15	Spring or fall	Poor control of grasses.

FARM SPRAYER CALIBRATION AND ADJUSTMENT

UNIFORM APPLICATION of spray chemicals is essential to control weeds. A small variation in the rate of application may result in poor kill of the weeds or injury to the crop, thereby causing a loss of time, effort, and money.

A simple method for determining the amount of liquid a sprayer applies per acre is as follows:

1. Start with a full tank of clean water and have the pressure adjusted as you will use it in the field (usually 30 to 40 pounds).

2. Drive exactly ⅛ of a mile (40 rods) in a field at the speed you will use when spraying—usually 4 to 5 miles per hour. Mark the notch the throttle is in and keep it in that notch when spraying.

3. Refill the tank, carefully measuring the amount of liquid required. (If water spillage from a full tank is a problem, a calibrated stick can be used to measure amount of liquid used.)

For broadcast applications

Calculate the application rate as follows:

$$\frac{\text{Number of gallons used} \times 66}{\text{Boom width in feet}} = \text{gallons per acre.}$$

Example: if 2½ gallons were used in ⅛ mile and the width covered by the boom is 24 feet, multiply 2½ by 66 and divide by 24. The result is 6.9 gallons per acre.

$$\frac{2.5 \times 66}{24} = \frac{165}{24} = 6.9 \text{ gallons per acre.}$$

For band applications

Calculate the application rate as follows:

$$\frac{\text{Number of gallons used} \times 66}{\text{Band width in feet} \times \text{Number of bands}} = \text{gallons per acre}$$

Example: If 1 gallon was used in ⅛ mile and sprayer applies 4 bands 1 foot in width, multiply 1×66 and divide by 1×4. The result is 16.5 gallons per acre. **This is the volume per acre being applied within the band.**

Here is the way to determine the amount of herbicide to put in the tank.

1. Divide the number of gallons the tank will hold by the number of gallons your sprayer applies per acre. This will give you the number of acres one filling will spray.

2. Multiply the number of acres the tank will spray by the amount of herbicide to be used per acre. This will give the amount of herbicide to be used per tank.

Example: If the tank holds 55 gallons and the sprayer applies 6.9 gallons per acre, one tank will spray 8.0 acres (55 divided by 6.9 equals 8.0). If 1 pint of spray material is required per acre, 8.0 pints would be required for each tankful. That is, 1 pint per acre $\times$ 8 acres = 8.0 pints per tankful.

Trade names are sometimes used in this publication to clearly identify the herbicide under discussion. Omission of other trade names of similar herbicides is unintentional. The inclusion of a trade name does not imply endorsement nor does exclusion imply nonapproval.

DESCRIPTION OF HERBICIDES

Rates refer to acid equivalent or active ingredient. Avoid repeated and prolonged contact with all herbicides—especially direct contact with the skin and eyes.

Amiben—3-amino-2,5-dichlorobenzoic acid, amine salt

Amitrole—3-amino-1,2,4-triazole, Amino-Triazole, Weedazol

Amitrole-T—amitrole plus sodium-thiocyanate, Amitrol-T, Cytrol

Atrazine—2-chloro-4-isopropylamino-6-ethylamino-s-triazine

Barban—2-chloro-2-butynyl-N-(3-chorophenyl) carbamate, Carbyne

BDM—borate and 2,4-D mixture, DB Granular

BMM—borate and monuron mixture, Ureabor

Borascu, concentrated—contains 61.5 percent B_2O_3

CDAA—2-chloro-N, N-diallylacetamide, Randox

CDAA-T—CDAA and trichlorobenzyl chloride mixture, Randox-T

Dalapon—sodium salt of 2,2-dichloropropionic acid, Dowpon

DATC—2,3-dichloroallyl diisopropylthiolcarbamate, Avadex

DATC-BW—2,3,3-trichlorallyl diisopropylthiolcarbamate, Avadex-BW

Diuron—3-(3,4-dichlorophenyl)-1, 1-dimethylurea, Karmex

DNBP amine salt—Premerge, Sinox PE

Erbon—2-(2,4,5-trichlorophenoxy)-ethyl-2-2-dichloropropionate, Baron

EPTC—ethyl N, N-di-n-propylthiolcarbamate, Eptam

Fenuron—3-(phenyl)-1,1-dimethylurea, Dybar

MCPA—sodium or amine salt of 2-methyl-4-chlorophenoxyacetic acid

Monuron—3-(chlorophenyl)-1,1-dimethylurea, Telvar

NPA—N-1-napthyl phthalamic acid; Alanap is the sodium salt

PBA—polychlorobenzoic acid

PCP-sodium salt of pentachlorophenol, water soluble

PEBC—propyl ethyl n-butylthiolcarbamate, Tillam

Polybor chlorate—contains 50 percent B_2O_3 and 25 percent sodium chlorate

Silvex—2-(2,4,5-trichlorophenoxy) propionic acid

Simazine—2-chloro-4,6-bis(ethylamino)-s-triazine

Sodium chlorate—highly flammable when mixed with organic materials

TBA—trichlorobenzoic acid, Benzac, Trysben

TCA—Sodium salt of trichloracetic acid

2,4-D—2,4-dichlorophenoxyacetic acid salts and esters

4-(2,4-DB)—amine salt of 4-(2,4-dichlorophenoxy) butyric acid

2,4,5-T—2,4,5-trichlorophenoxyacetic acid, amine salts and esters

Urab—3-phenyl-1, 1-dimethylurea trichloroacetate

Urox—3-(chlorophenyl)-1, 1-dimethylurea trichloroacetate

WHEN USING AGRICULTURAL CHEMICALS FOLLOW LABEL INSTRUCTIONS CAREFULLY

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